Hall Ticket No | | | | | | | | | | Question Paper Code: AAE009

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-I

B.Tech V Semester End Examinations, November/December – 2019

Regulations: IARE - R16

FINITE ELEMENT METHODS

(AERONAUTICAL ENGINEERING)

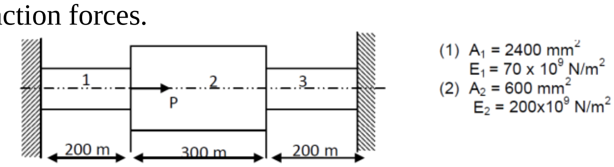
Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

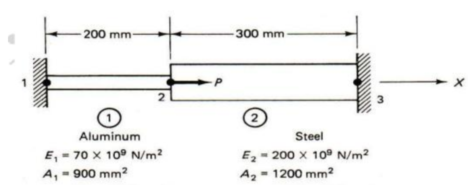
1. a) Explain the strain – displacement relations. **[7M]**

   b) An axial load P = 200X103 N is applied on a bar shown. Using the penalty approach for handling boundary conditions, determine nodal displacements, stress in each material and reaction forces. **[7M]**



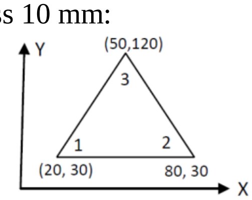
2. a) Discuss the basic steps involved in FEM and explain in detail **[7M]**

   b) Determine the displacements and the support reactions for the uniform bar shown in figure. Given P=300KN. **[7M]**



UNIT – II

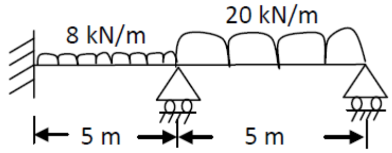
3. a) Evaluate the stiffness matrix for the elements shown in figure below. The coordinates are given in units of millimeters. Assume plane stress conditions. Let E = 210 GPa, passion ratio 0.25, and thickness 10 mm: **[7M]**



   b) Derive the element stiffness matrix for a 2-noded beam element. **[7M]**

4. a) Derive element stiffness matrix for two dimensional truss element. **[7M]**

b) Analyze the beam shown in figure by finite element method and determine the end reactions. Also determine the deflections at mid spans given E = 2 x 10^5 N/mm^2 and I= 5 x 10^5nm^4. **[7M]**



UNIT – III

5. a) Derive the strain-displacement matrix, stiffness matrix and nodal load vectors for a linear strain triangular element. **[7M]**

b) Two dimensional simple elements are used to find the pressure distribution in a fluid medium. The (x, y) coordinates of nodes i, j and k of an element are given by (2,4), (4,0) and (2,6) respectively. Find the shape functions Ni, Nj and Nk of the element. **[7M]**

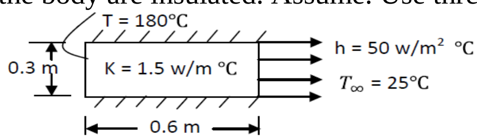
6. a) Write short notes on: **[7M]**
(i) Uniqueness of mapping of isoparametric elements. (ii) Gaussian quadrature integration technique.

b) Triangular elements are used for stress analysis of a plate subjected to in-plane load. The components of displacement parallel to (x, y) axes at the nodes i, j and k of an element are found to be (- 0.001, 0.01), (-0.002, 0.01) and (- 0.002, 0.02) cm respectively. If the (x, y) coordinates of the nodes i, j and j are (20, 20), (40, 20) and (40, 40) in cm respectively, find (a) the distribution of the (x, y) displacement components inside the element and (b) the components of displacement of the point (xp,yp) = (30, 25) cm. **[7M]**

UNIT – IV

7. a) Explain 2-D finite element formulation in heat transfer analysis **[7M]**

b) For the 2-D body shown in figure, determine the temperature distribution. The edges on the top and bottom of the body are insulated. Assume. Use three element models. **[7M]**



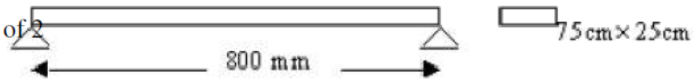
8. a) Write in general the process of formulation of the thermal stresses in engineering problems. **[7M]**

b) A composite slab consists of three materials of different conductivities is 20 W/mk, 30 W/mk and 50 W/mk of thickness 0.3 m , 0.15m and 0.15m respectively. The outer surface is 200C and the inner surface is exposed to the convective heat transfer coefficient of 25 W/m2k at 3000C. Determine the temperature distribution within the wall. **[7M]**

UNIT – V

9. a) Discuss the methodology to solve the Eigen value problem for the estimation of natural frequencies of a stepped bar. **[7M]**

b) Determine the natural frequencies of a simply supported beam of length 800 mm with the cross sectional area of 75 cm X 25 cm as shown in the figure **[7M]**
Take E= 200 Gpa and density of 7850 kg/m3.



10 a) Differentiate lumped mass matrix and consistent mass matrix. **[7M]**

b) Find the natural frequencies and the corresponding mode shapes for the longitudinal vibrations for a stepped bar having A1 = 2A and A2 = A ; I1 = I2 = I & ; E1 = E2 = E. **[7M]**

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COURSE OBJECTIVES:

I	Introduce basic concepts of finite element methods including domain discretization, polynomial interpolation and application of boundary conditions.
II	Understand the theoretical basics of governing equations and convergence criteria of finite element method.
III	Develop of mathematical model for physical problems and concept of discretization of continuum
IV	Discuss the accurate Finite Element Solutions for the various field problems
V	Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems

COURSE OUTCOMES (COs):

CO 1	Describe the concept of FEM and difference between the FEM with other methods and problems based on 1-D bar elements and shape functions.
CO 2	Derive elemental properties and shape functions for truss and beam elements and related problems.
CO 3	Understand the concept deriving the elemental matrix and solving the basic problems of CST and axi-symmetric solids.
CO 4	Explore the concept of steady state heat transfer in fin and composite slab.
CO 5	Understand the concept of consistent and lumped mass models and slove the dynamic analysis of all types of elements.

COURSE LEARNING OUTCOMES (CLOs):

AAE009.01	Describe the basic concepts of FEM and steps involved in it.
AAE009.02	Understand the difference between the FEM and Other methods.
AAE009.03	Understand the stress-strain relation for 2-D and their field problem.
AAE009.04	Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundary conditions
AAE009.05	Apply numerical methods for solving one dimensional bar problems
AAE009.06	Derive the elemental property matrix for beam and bar elements.
AAE009.07	Solve the equations of truss and beam elements
AAE009.08	Understand the concepts of shape functions for beam element.

AAE009.09	Apply the numerical methods for solving truss and beam problems
AAE009.10	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.
AAE009.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems
AAE009.12	Understand the concept of CST and LST and their shape functions.
AAE009.13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.
AAE009.14	Derive the stiffnes matrix for for fin element.
AAE009.15	Solve the steady state heat transfer problems for fin and composite slab.
AAE009.16	Understand the concepts of mass and spring system and derive the equations for various structural problems
AAE009.17	Understand the concept of dynamic analysis for all types of elements.
AAE009.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.

MAPPING OF SEMESTER END EXAMINATION TO COURSE OUTCOMES

SEE Question No.		Course Learning Outcomes		Course Outcomes	Blooms' Taxonomy Level
1	a	AAE009.03	Understand the stress-strain relation for 2-D and their field problem.	CO 1	Remember
	b	AAE009.05	Apply numerical methods for solving one dimensional bar problems	CO 1	Understand
2	a	AAE009.01	Describe the basic concepts of FEM and steps involved in it.	CO 1	Remember
	b	AAE009.05	Apply numerical methods for solving one dimensional bar problems	CO 1	Understand
3	a	AAE009.09	Apply the numerical methods for solving truss and beam problems	CO 2	Understand
	b	AAE009.08	Understand the concepts of shape functions for beam element.	CO 2	Understand
4	a	AAE009.07	Solve the equations of truss and beam elements	CO 2	Remember
	b	AAE009.09	Apply the numerical methods for solving truss and beam problems	CO 2	Understand
5	a	AAE009.10	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.	CO 3	Understand
	b	AAE009.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems	CO 3	Understand
6	a	AAE009.12	Understand the concept of CST and LST and their shape functions.	CO 3	Understand
	b	AAE009.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems	CO 3	Understand
7	a	AAE009.13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.	CO 4	Remember
	b	AAE009.15	Solve the steady state heat transfer problems for fin and composite slab.	CO 4	Understand

8	a	AAE009.14	Derive the stiffnes matrix for for fin element.	CO 4	Remember
	b	AAE009.15	Solve the steady state heat transfer problems for fin and composite slab.	CO 4	Understand
9	a	AAE009.17	Understand the concept of dynamic analysis for all types of elements.	CO 5	Remember
	b	AAE009.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.	CO 5	Understand
10	a	AAE009.16	Understand the concepts of mass and spring system and derive the equations for various structural problems	CO 5	Remember
	b	AAE009.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.	CO 5	Understand

Signature of Course Coordinator **HOD, AE**